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In Re Application Of: **Martin Klein et al.**

Application No.	Filing Date	Examiner	Customer No.	Group Art Unit	Confirmation No.
10/047,556	October 23, 2001	Lee, S.	001218	2884	4171

Invention: **DETECTOR**

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Group Art Unit: 2884
Examiner: Lee, S.

Atty. Ref.: H 2182

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT OPERATION

Applicants : Martin Klein et al.

Appl. No. : 10/047,556

Filed : October 23, 2001

For : DETECTOR

MS Appeal Brief-Patents
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APPEAL BRIEF

Sir:

Appellants submit this Appeal Brief in response to the Examiner's Final Rejection, dated July 21, 2006, of Claims 1-3, 5, 6, 8-10, 13-15, 17 and 18 and the Advisory Action dated December 19, 2006.

(i) Real Party in Interest

The real party in interest is Universitat Heidelberg, Heidelberg, Germany.

(ii) Related Appeals and Interferences

There are no interferences related to the present application. An appeal brief was filed on July 18, 2005. Then a Notice of defective Appeal Brief was issued and Applicants filed a Request for Continued Examination on October 19, 2005. No decision was rendered by a court or the Board of Patent Appeals and Interferences.

(iii) Status of Claims

Claims 1-3, 5, 6, 8-10, 13-15, 17 and 18 have been finally rejected.

(iv) Status of Amendments

No Amendment was filed in response to the final rejection.

(v) Summary of Claimed Subject Matter

The present invention relates to a detector for detecting electrically neutral particles, to a converter device for a detector for detecting electrically neutral particles, to a method for producing a converter device and to a detection method for detecting electrically neutral particles.

Accordingly, the present invention provides a detector for detecting electrically neutral particles, to a converter device for a detector for detecting electrically neutral particles, to a

method for producing a converter device and to a detection method for detecting electrically neutral particles. By way of example, a reading of independent claims 1, 13 and 14, on the specification and drawings is as follows:

1. A detector [0008, Figs. 1-4] for detecting electrically neutral particles [0009] comprising:

a detector housing [0009; 0037; Fig. 2 (10)] which at least in certain regions is filled with a counting gas [0009],

a multiplicity of converter devices [0012; 0021; 0039, Fig. 2 (22)] arranged in cascade form [0012] in the detector housing [0009; 0037; Fig. 2 (10)] for generating conversion products [0008] as a result of the absorption of the neutral particles which are to be detected [0009], the conversion products generating electrically charged particles in the counting gas [0009], each of said converter devices [0012; 0021; 0039, Fig. 2 (22)] comprising an insulator layer [0015; 0021; 0040; Fig. 2 (26)] having opposite first and second surfaces, a first conductive layer [0015; 0021; 0040; Fig. 2 (28)] and second conductive layer [0015; 0021; 0040; Fig. 2 (30)] disposed respectively on the first and second surfaces of the insulator layer [0015; 0021; 0040; Fig. 2 (26)] such that the first and second conductive layers are electrically insulated from one another by the insulator layer [0015; 0021; 0040; Fig. 2 (26)], and at least one converter layer [0015; 0040; Fig. 2 (24)] arranged on at least one of the first conductive layer [0015; 0021; 0040; Fig. 2 (28)] and the second conductive layer [0015; 0021; 0040; Fig. 2 (30)] to define an outermost part of each said converter device [0012; 0021; 0039, Fig. 2 (22)], the converter layer being formed of a material different than the conductive layer on which the converter layer is arranged [0040],

at least one readout device [0008; 0038; Fig. 2 (19)] for detecting the electrically charged particles [0008],

at least one electrical drift field device [0008-0009; 0016; Fig. 2 (18)] for generating an electrical drift field [0015-0016] for the electrically charged particles in at least a region of the volume of the counting gas [0008-0009] in such a manner that at least some of the electrically charged particles drift toward the readout device [0010; 0015-0016], the converter device being a charge-transparent design [0008-0009] and being arranged in the detector housing [0008-0009] in such a manner that the drift field [0008-0009; 0015-0016] passes through at least part of each said converter device [0008-0009; 0015-0016].

13. A method for producing a converter [0008] for a detector [0008, Figs. 1-4] for detecting electrically neutral particles [0023] comprising the following steps:

providing a plurality of insulator layers [0023], each said insulator layer [0015; 0021; 0040; Fig. 2 (26)] having opposite surfaces [Figs. 1-4 (26)] and two electrically conductive layers [0015; 0021; 0040; Fig. 2 (28); Fig. 2 (30)] disposed respectively on the opposite surfaces of each respective insulator layer [0015; 0021; 0040; Fig. 2 (26)], so that the electrically conductive layers are electrically insulated from one another [0015], each said insulator layer [0015; 0021; 0040; Fig. 2 (26)] and the electrically conductive layers [0015; 0021; 0040; Fig. 2 (28); Fig. 2 (30)] adjacent thereto defining a converter device [0012; 0021; 0039, Fig. 2 (22)];

providing a converter layer [0015; 0040; Fig. 2 (24)] arranged on at least one of the conductive layers [0015; 0021; 0040; Fig. 2 (28); Fig. 2 (30)] of each said converter device

[0012; 0021; 0039, Fig. 2 (22)], the converter device being formed of a material different than the conductive layer on which the converter layer is arranged [0040]; and

arranging a plurality of the converter devices [0012; 0021; 0039, Fig. 2 (22)] in a cascade form [0053].

14. A detection method for detecting electrically neutral particles [0025] comprising the following steps:

trapping the electrically neutral particles which are to be detected [0025] using a plurality of converter devices [0012; 0021; 0039, Fig. 2 (22)] arranged in a cascade form [0053] for generating conversion products when the neutral particles are absorbed, each said converter device having an insulator [0015; 0021; 0040; Fig. 2 (26)] with two opposite surfaces [Figs. 1-4 (26)], two electrically conductive layers [0015; 0021; 0040; Fig. 2 (28); Fig. 2 (30)] disposed respectively on the opposite surfaces of the insulator [0015; 0021; 0040; Fig. 2 (26)] so that the electrically conductive layers [0015; 0021; 0040; Fig. 2 (28); Fig. 2 (30)] are electrically insulated from one another, a converter layer [0015; 0040; Fig. 2 (24)] being provided on at least one of the conductive layers [0015; 0021; 0040; Fig. 2 (28)] of each said converter device, the converter layer being formed of a material different than the conductive layer on which the converter layer is arranged [0040];

generating electrically charged particles in a counting gas by means of the conversion products [0025];

diverting the electrically charged particles in an electrical drift field to a readout device [0025], at least some of the electrically charged particles being passed through the converter devices [0012; 0021; 0025; 0039, Fig. 2 (22)] through a multiplicity of passages

[0010; 0040; Fig. 2 (32)], which are arranged in the form of a matrix, [0010; 0040] in the converter devices; and

detecting the electrically charged particles in the readout device [0025].

(vi) Ground for rejection to be reviewed on appeal

(a) Do the teachings of Danielsson et al., U.S. 6,429,578 in view of Gleason, U.S. 3,956,654 render obvious claims 1-2, 5, 6, 8-10, 13-15, 17 and 18 under 35 U.S.C. §103(a)?

(b) Do the teachings of Danielsson et al., U.S. 6,429,578 in view of Gleason, U.S. 3,956,654 as applied to claim 2 above, and further in view of Sauli, U.S. 6,011,265, render obvious claim 3 under 35 U.S.C. §103(a)?

(vii) Argument

(a) The §103(a) rejection of claims 1-2, 5, 6, 8-10, 13-15, 17 and 18 under 35 U.S.C. §103(a) as being obvious over Danielsson et al., U.S. 6,429,578 (hereinafter "Danielsson et al.") in view of Gleason, U.S. 3,956,654.

The claims of the present invention are directed towards a plurality of converter devices, each of which has first and second conductive layers disposed respectively on opposite first and second surfaces of an insulator layer. Each converter device has at least one converter layer arranged on at least one of the first and second conductive layers to define an outermost part of each converter device. Significantly, the converter layer of the claims is "formed from a material different than the conductive layer on which the converter layer is arranged"(*see* the original specification, e.g. ¶ 40 (emphasis added)).

The invention, as defined by the claims of the present application, has a significant advantage over Danielsson et al. Specifically, the subject invention permits a converter material to be chosen in view of the specific purpose of the converter device and irrespective of the electrode material used by the GEM foil. Danielsson et al. does not allow such a choice because Danielsson et al. is always limited to the electrode being used simultaneously as a converter. Furthermore, the separate converter layer formed from the material different from the conductive layer on which the converter layer is arranged can produce much greater absorption efficiency.

The greater absorption efficiency achieved with the claimed invention as compared to Danielsson et al. is supported by the Rule 132 Declaration submitted concurrently with the Amendment dated May 5, 2006 (also attached hereto, *see* section (ix)). The Rule 132 Declaration includes a graph that presents a simulation analysis carried out by the declarant (Martin Klein). The three lines in the graph show absorption efficiency for X-rays having energies between 10 keV and 150 keV.

The lowest of the three lines on the graph depicts simulated absorption efficiencies of a conventional GEM foil having copper electrodes with a thickness of 5 micrometers. One of the copper foil electrodes simultaneously acts as a converter layer.

The middle of the three lines in the graph simulates a GEM foil having a copper converter applied on top of one of the copper electrodes of the GEM foil. The additional copper converter layer was simulated to have a thickness of 5 micrometers. Thus, a 10 micrometer thick copper layer (5 micrometers electrode, 5 micrometers converter) exists on one side of the converter device simulated by the middle of the three lines. Accordingly, the converter device depicted by the middle of the three lines on the graph

simulates the embodiment of Danielsson et al. as set forth in claim 11 (as referenced by the Examiner in the Office Action dated February 2, 2006 at page 9).

The upper of the three lines shown in the graph corresponds to the claimed invention. In particular, the upper of the three lines simulates a converter device with a conventional GEM foil. In the third simulation, the converter layer is gold while the electrode is copper. Gold was considered by the declarant to be an appropriate converter for X-ray detection and hence was considered to provide a meaningful comparison to Danielsson et al. The graph of these three simulations clearly shows that the claimed invention provides very significantly enhanced absorption efficiencies as compared to both the conventional GEM foil and as compared to Danielsson et al. In this regard, it should be appreciated that the vertical axis of the graph is a logarithmic scale. Accordingly, the upper line in the graph demonstrates an absorption efficiency that is as much as ten times greater than Danielsson et al.

The Danielsson et al. reference discloses two embodiments. The embodiment of Fig. 3 shows a plurality of GEM foils in a cascaded arrangement. The Fig. 3 embodiment also shows a converter device between two neighboring GEM foils and independent of those GEM foils.

The second embodiment of Danielsson el al. is illustrated in Figs. 7A and 9. The second embodiment has a cascaded arrangement of converter devices. Each of the converter devices in the second embodiment is a five-layer structure. The final rejection (dated July 21, 2006) refers to the two Danielsson et al. embodiments collectively even thought those two embodiments are structurally and functionally different from one another. It is submitted that nothing in Danielsson et al. or the cited prior art would

motivate the skilled artisan to modify the Danielsson et al. Fig. 2A or 3 embodiments by providing an additional converter layer <u>on</u> the GEM foil. This hypothetical reconstruction of the Danielsson et al. Fig. 2A or 3 embodiments would be highly unlikely because converter devices already are arranged between the GEM foils. The skilled artisan who wanted to modify the Danielsson et al. Fig. 2A or 3 embodiment merely would be likely to provide a combined converter-amplifier device in the Fig. 2A or 3 embodiment in view of the fact that such a converter-amplifier device is disclosed by the second embodiment of Danielsson et al. depicted in Figs. 7A and 9.

The first and second embodiments of Danielsson et al. are both different from the subject matter defined by the claims of the present application. Modifying the Danielsson et al. Fig. 3 embodiment by arranging an additional converter layer on the GEM foil is not suggested anywhere in the cited prior art, and was first suggested by the Applicants of the present invention.

As noted above, the skilled artisan arguably might modify the Danielsson et al. Fig. 2A and 3 embodiment by modifying the isolating layer (204), which is arranged within the interior GEM foil to become a converter layer similar to the converter layer (708) in Fig. 7A of Danielsson et al. With that hypothetical change, the skilled artisan would make the middle insulating layer from a converter material, such as boron. However, the skilled artisan would not arrange such a boron layer to be the outermost layer of the GEM foil, since there is no indication or suggestion thereof in the cited prior art. Further, the cited prior art teaches a different arrangement in the center of the amplifying device. Therefore, it is submitted that there is no motivation for the skilled artisan to make the changes that

would bring Danielsson et al. closer to the claimed invention. See *Winner Intern. Royalty Corp. v. Wang*, 202 F.3d 1340, 1348-49 (Fed. Cir. 2000).

Upon review of the Office Action dated July 21, 2006 and the Advisory Action dated December 19, 2006 it appears that the Examiner is relying on the Gleason reference solely for its teaching of the use of boron-10 as an absorptive material for detecting neutrons (see Gleason at col. 1, lines 9-36). Applicants submit that the general teaching of the use of boron-10 in a neutron detector does nothing to alleviate the myriad deficiencies in the teaching of Danielsson et al. As recited above, the teaching of Danielsson et al. do not render the claims of the present application obvious. Furthermore, the instruction that boron-10 can be employed as an absorptive material does not fill the void of teachings that separate Danielsson et al. from the claims of the present invention.

Applicants, therefore, respectfully request reversal of the above 103(a) rejection.

(b) The 35 U.S.C. §103(a) rejection of Claim 3 as being obvious over Danielsson et al. in view of Gleason as applied to claim 2, and further in view of Sauli, U.S. 6,011,265 (hereinafter "Sauli").

Sauli does not teach cascading a multiplicity of converter devices. Rather, Sauli teaches that such cascading is not possible. At col. 21, lines 53-57, Sauli explains that "the detection unit may well include another gas electron multiplier so as to form a multi-stage <u>gas electron multiplier</u>." Sauli does not suggest adding another converter layer, such as a photocathode. Rather, it is clear from Sauli that another photocathode layer is completely pointless, since no photons can pass through the first photocathode layer having "an optical transparency close to zero" (col. 23, lines 34-35).

Furthermore, Sauli discusses the influence of secondary photons. It should be pointed out that the secondary photons are photons that should not be detected. Secondary photons have a negative influence on the detection signal, and effectively constitute noise. Moreover, secondary photons are generated by recombination processes which occur locally after the first GEM structure having a photocathode thereon. More particularly, secondary photons typically occur in the gap between the first and the second GEM foil (and in the gap between the neighboring further GEM foils). Hence, the second GEM foil of Sauli is not provided with a photocathode. This is consistent with the argument of Sauli that:

> "secondary [photons] in the second stage element cannot heat the photocathode layer PhC thereby preventing to induce secondary emission." *See* Sauli col. 23, lines 29-31.

The negative influence of secondary photons due to the heating of the photocathode layer is discussed in detail in "Advantages in Gas Avalanche Photomultiplier" by Breskin et al., dated June 1999 (a copy of which was submitted with the Information Disclosure Statement filed on May 5, 2006 (also attached hereto at section ix)). In particular section "4. Electron Multipliers" on page 6 of this publication refers to Figs. 8 and 10, and asserts that the GEM:

> "would transmit photoelectrons into the multipliers, while screening the photocathode from avalanche-induced feedbacks photons"

The "avalanche-induced feedback photons" represent the secondary photons, referred to by Sauli. Moreover, page 7 of the Breskin et al. publication states that

> "almost complete elimination of photon feedback effects in multi-GEM structures permits, for the first time, reaching very high gain" Even more, "the deposition of the photocathode on top of the GEM surface (figure 11) should permit an operation free of photon feedback effects"

Clearly, the Breskin et al. publication draws the same conclusion as Sauli, namely that the photocathode layer can only be arranged on the topmost face of a detector device having a plurality of converter devices. This is exactly the statement that Sauli makes, which actually teaches away from the present invention.

Following that, when combings Sauli and Danielsson et al., Sauli teaches to avoid heating of the converter layer by arranging a converter layer exclusively on the topmost multiplication stage followed by a plurality of pure multiplication stages with no converter layers. Further, Sauli teaches that consecutive arrangement of converter devices would lead to unavoidable heating of the converter devices, thereby teaching the skilled artisan that heating by secondary photons is to be avoided.

Danielsson et al., on the other hand, provides different ways of cascaded converter devices. In particular, Danielsson et al., teaches that cascaded converter devices have an electrode <u>used as converter devices</u>. However, taking into account Sauli, the skilled artisan would realize the disadvantage of such an array and, rather, would provide no further converter layers in the consecutive amplification stages (according to Sauli). Alternatively, the skilled artisan would employ the converter devices according to Danielsson et al., such as the one shown in Fig. 7A of Danielsson et al., which would avoid heating of the converter device by protecting it from impact with secondary photons due to the arrangement of the converter device in the core of the structure.

However, the applicants of the present invention surprisingly discovered that the conclusion drawn by Sauli in not valid. Particularly, the applicants discovered that cascading a plurality of converter devices, each having an individual converter layer, is

indeed very practical and that heating of the converter layers due to the secondary photons is negligible.

Applicants, therefore, respectfully request reversal of the above 103(a) rejection.

In summary, the presently claimed invention is not taught or suggested by the hypothetical combination of Danielsson et al, Gleason and/or Sauli. To the contrary, a skilled artisan would be led away form the subject matter of the claims of the present invention due to the deficiencies pointed out by Sauli. Accordingly the claims are believe to be allowable over the cited prior art of record.

Applicants, therefore, respectfully request reversal of the 103(a) rejections.

Respectfully submitted,

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Date: January 24, 2007

(viii) Appendix – Claims on Appeal

1. A detector for detecting electrically neutral particles comprising:

a detector housing which at least in certain regions is filled with a counting gas,

a multiplicity of converter devices arranged in cascade form in the detector housing for generating conversion products as a result of the absorption of the neutral particles which are to be detected, the conversion products generating electrically charged particles in the counting gas, each of said converter devices comprising an insulator layer having opposite first and second surfaces, a first conductive layer and second conductive layer disposed respectively on the first and second surfaces of the insulator layer such that the first and second conductive layers are electrically insulated from one another by the insulator layer, and at least one converter layer arranged on at least one of the first conductive layer and the second conductive layer to define an outermost part of each said converter device, the converter layer being formed of a material different than the conductive layer on which the converter layer is arranged,

at least one readout device for detecting the electrically charged particles,

at least one electrical drift field device for generating an electrical drift field for the electrically charged particles in at least a region of the volume of the counting gas in such a manner that at least some of the electrically charged particles drift toward the readout device, the converter device being a charge-transparent design and being arranged in the detector housing in such a manner that the drift field passes through at least part of each said converter device.

2. The detector as claimed in claim 1, in which each said converter device has a multiplicity of passages, for the electrically charged particles.

3. The detector as claimed in claim 2, in which the passages have a minimum diameter of between 10 μm and 1000 μm, and a minimum spacing of 10 μm to 500 μm.

Claim 4 (canceled).

5. The detector as claimed in claim 1, in which a region of each said converter device which is active in the conversion is arranged substantially perpendicularly in the drift field.

6. The detector as claimed in claim 1, in which the device for generating a drift field has a structured drift electrode to generate the drift field between the drift electrode and the readout device.

Claim 7 (canceled).

8. The detector as claimed in claim 1, in which the first conductive layer and second conductive layer are electrically connected to a device for generating a converter field.

9. The detector as claimed in claim 8, in which the converter layer is a neutron converter layer which contains at least one of lithium-6, boron-10, gadolinium-155, gadolinium-157 and uranium-235.

10. The detector as claimed in claim 9, in which the converter layer has a layer thickness of from 0.1 μm to 10 μm, the first and second conductive layers have a layer thickness of from 0.1 μm to 20 μm, and the insulator layer has a thickness of from 10 μm to 500 μm.

Claims 11 and 12 (canceled).

13. A method for producing a converter for a detector for detecting electrically neutral particles comprising the following steps:

providing a plurality of insulator layers, each said insulator layer having opposite surfaces and two electrically conductive layers disposed respectively on the opposite surfaces of each respective insulator layer, so that the electrically conductive layers are electrically insulated from one another, each said insulator layer and the electrically conductive layers adjacent thereto defining a converter device;

providing a converter layer arranged on at least one of the conductive layers of each said converter device, the converter device being formed of a material different than the conductive layer on which the converter layer is arranged; and

arranging a plurality of the converter devices in a cascade form.

14. A detection method for detecting electrically neutral particles comprising the following steps:

trapping the electrically neutral particles which are to be detected using a plurality of converter devices arranged in a cascade form for generating conversion products when the neutral particles are absorbed, each said converter device having an insulator with two opposite surfaces, two electrically conductive layers disposed respectively on the opposite surfaces of the insulator so that the electrically conductive layers are electrically insulated from one another, a converter layer being provided on at least one of the conductive layers of each said converter device, the converter layer being formed of a material different than the conductive layer on which the converter layer is arranged;

generating electrically charged particles in a counting gas by means of the conversion products;

diverting the electrically charged particles in an electrical drift field to a readout device, at least some of the electrically charged particles being passed through the converter devices through a multiplicity of passages, which are arranged in the form of a matrix, in the converter devices; and

detecting the electrically charged particles in the readout device.

15. The detector as claimed in claim 1, wherein the insulator layer in each of said converter devices is the only insulator layer thereof.

Claim 16 (canceled).

17. The method of claim 13, wherein the insulator layer in each of said converter devices is the only insulator layer thereof.

18. The method of claim 14, wherein the insulator layer in each of said converter devices is the only insulator layer thereof.

(ix) Evidence Appendix

United States Patent Nos. 6,429,578; 3,956,654 and 6,011,265 are attached hereto.

Declaration Under 37 C.F.R. §1.132 of Martin Klein is attached hereto.

"*Advantages in Gas Avalanche Photomultiplier*" by Breskin et al., dated June 1999 is attached hereto.

(x) Related Proceedings Appendix

There have been no decisions rendered by a court or the Board of Patent Appeals and Interferences related to the present application.